U.S. House of Representatives
Committee on Transportation and Infrastructure
Washington, DC 20515

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SUMMARY OF SUBJECT MATTER

TO: Members of the Subcommittee on Water Resources and Environment

FROM: Subcommittee on Water Resources and Environment Staff

SUBJECT: Hearing on Sustainable Wastewater Infrastructure

PURPOSE OF HEARING

On Wednesday, February 4, 2009, at 10:00 a.m., in Room 2167 Rayburn House Office Building, the Subcommittee on Water Resources and Environment will receive testimony from representatives from the United States Environmental Protection Agency, the Lawrence Berkeley National Laboratory, the Water Environment Federation, and other organizations on sustainable wastewater infrastructure. The purpose of this hearing is to gather information about various technologies and approaches for sustainable infrastructure in wastewater treatment facilities.

BACKGROUND

In both the 110th and 111th Congresses, legislation has passed the House of Representatives which has included provisions promoting innovation in, and the use of sustainable infrastructure for wastewater treatment facilities. This briefing memorandum introduces some of these sustainable approaches. Much of the nation's wastewater infrastructure was built in the three decades following the Second World War. This includes approximately 6,000 publicly owned treatment works (POTWs). In the process of constructing, replacing and rehabilitating wastewater infrastructure, opportunity exists for municipalities and facility operators to explore alternatives to traditional designs and technologies. These could include energy and water efficient processes and technologies.

On January 28, 2009, the U.S. House of Representatives passed H.R. 1, the American Recovery and Reinvestment Act of 2009. The legislation includes set aside grant funding for sustainable wastewater infrastructure. Funding, pursuant to this provision, would be for projects to implement processes, materials, techniques, or technologies to address water-efficiency goals, to address energy-efficiency goals, to mitigate stormwater runoff, or to encourage environmentally-sensitive project planning, design, and construction.

In the 110th Congress, the House passed H.R. 720, the Water Quality Financing Act of 2007. This legislation included provisions to implement innovative or alternative processes, materials, techniques, or technologies that may result in greater environmental benefits, or equivalent environmental benefits at reduced cost for water quality improvements.

Integration of these approaches and technologies into a wastewater facility's operations may help to reduce climate impacts, save money, and save water. Identifying approaches to integrate energy efficient practices into the daily management and long-term planning of the water sector also contribute to the long-term sustainability of water infrastructure by reducing operation costs and adding to a utility's bottom line.

Sustainable Infrastructure – Water

Sustainable water infrastructure can apply to a number of areas including the efficient use of water, water conservation, as well as more effective mitigation of stormwater impacts.

Water Efficiency: Technologies and practices that require less water to achieve an equivalent result can yield a number of benefits. These include: fewer sewage system failures caused from excess water overwhelming the system; reduced need to construct additional water and wastewater treatment facilities; elimination of excessive surface water withdrawals that degrade habitat both in streams and on land adjacent to streams and lakes. Finally, efficient water use can also reduce the amount of energy needed to treat wastewater, resulting in less energy demand and, therefore, fewer harmful byproducts from power plants.

Stormwater Mitigation: Impermeable surfaces, commonly associated with roads and rooftops and concentrated in urban areas, are a leading source of excessive stormwater flows. A pre-development landscape allows for precipitation to infiltrate into the ground, as opposed to its conveyance across the ground to enter surface waters. In a pre-development landscape, runoff is less than 10% of the rainfall volume. A developed landscape with impermeable surfaces does not allow any rainfall to infiltrate into the ground.

Urban stormwater is frequently captured by a separate stormwater system, or by a municipal sewer collection system. The former is conveyed directly to a water body, such as a stream or river, and released with little or no treatment. The latter results in stormwater being taken through the sewer collection system to a wastewater treatment facility to be treated and eventually released as a cleaner discharge.

Most U.S. cities use separate stormwater sewer systems. Any particulates or pollutants that are picked up by the stormwater are conveyed through the system and are discharged directly into the water body. The large volumes of stormwater (as a result of increased runoff as a function of higher proportions of impermeable surfaces) often result in streambank erosion and the deposition of nutrients, pet waste, and roadway pollutants (oils, metals, chemicals) into the recipient water.

In older cities, primarily in the northeast and the Great Lakes states, stormwater flows into the same pipes as sewage. In non-wet weather events, the stormwater is conveyed to a treatment facility and discharged as cleaner effluent. In order not to overwhelm wastewater treatment facilities, many of these collection systems are designed to overflow ('upstream' of the facility) during wet weather events. This results in untreated stormwater, sewage, and industrial effluent being deposited directly into water bodies. This is known as a combined sewer overflow (CSO).

A 'hard infrastructure' approach to mitigating CSO events is to construct storage capacity whereby stormwater and sewage can be contained until after the wet weather event is over. The material would then be released to the wastewater facility for treatment. A number of cities have constructed deep tunnels to store wet weather capacity. As a result of their very large holding capacity these are long term projects, and are also very expensive. For example, Chicago's tunnel has a project construction lifespan of over 40 years, and is not expected to be completed until 2019. It is expected to cost $3.4 billion.

A 'green infrastructure' approach for stormwater mitigation is premised on the notion that the volume of stormwater should be reduced before entering into stormwater and/or sewage conveyance systems. Green infrastructure approaches for stormwater mitigation provide more opportunities for infiltration to occur in a developed landscape – thereby lessening the amount of runoff. Examples of these technologies include green roofs, permeable pavement, curb cut-outs leading to vegetated areas, rain gardens, increased tree cover, and rain swales[1]. Reducing runoff using these approaches decreases the amount of stormwater and pollution reaching waterways and relieves the strain on stormwater and wastewater infrastructure. The experiences of those cities that have experimented with these approaches have shown that these technologies can be cost-competitive with conventional, 'hard' infrastructure approaches for controlling stormwater. In addition, green infrastructure designed to mitigate stormwater has a number of other benefits. These include improved air quality, mitigation of urban heat island effects, energy savings (with regards to green roofs), and better urban aesthetics (yielding increased property values.)

Sustainable Infrastructure – Energy

Water utilities are significant consumers of energy, and are therefore responsible for large volumes of greenhouse gas emissions. The U.S. Environmental Protection Agency (EPA) and the Electric Power Research Institute estimate that approximately 56 billion kilowatt hours (kWh) are used for supply and treatment of drinking water supplies and POTWs. This is the equivalent of 44.8 million tons of green gas emissions. The Massachusetts Department of Environmental Protection has estimated that wastewater treatment accounts for 1.3% of energy usage across all industrial sectors in Massachusetts.[2] Oregon wastewater utilities use approximately five percent of the state's electricity, and energy accounts for about 15 percent of a typical wastewater treatment plant's budget. The Energy Information Administration estimates that water utility energy consumption is between 30-60% of a city's energy bill. EPA's Energy Star program estimates that approximately $4 billion is spent annually for energy costs (pumping and treatment) to operate water utilities. EPA

[1] Rain swales are shallow depressions that are designed to capture and store rainwater for a period of time, allowing for infiltration or slower water movement.

[2] They also find that drinking water treatment accounts for .74% of industrial emissions. Wastewater treatment, therefore, is nearly twice as energy intensive as drinking water treatment.

notes that a 10% reduction in energy usage could result in $400 million and 5 billion kWh in annual savings.

The majority of energy use at wastewater treatment facilities is a product of treatment processes (including aeration) and pumping. Energy use is affected by the size of the population served, influent loading, level of effluent quality, treatment process type, and the size and age of the treatment facility.

The following are technologies that could be incorporated into wastewater treatment facility systems to realize energy efficiency gains. Depending on the type of system and technologies included, it is possible for wastewater treatment facilities to achieve energy independence. Not only can wastewater treatment facilities become more energy efficient, they can generate energy. For example, biogas emitted from anaerobic digesters can by used to fuel on-site generators to provide electricity and power. An energy audit process can help to determine what technologies should be used to achieve facility energy objectives.

Fuel Cells Using Digester Gas: Traditionally, digester gas has been used in boilers to provide heat back to the digester and for heating of buildings. Often, excess gas is flared off. Digester gas can also be used to produce electricity in addition to heat. The most efficient way to utilize the energy in the digester gas is through a cogeneration system. Cogeneration is the simultaneous production of electricity and heat – both used in wastewater treatment facilities.

Fuel cells run on hydrogen or methane and generate electricity through a chemical reaction. Digester gas is used as the source of the methane. Methane molecules are broken down to allow the hydrogen to be used for the creation of electricity through the fuel cell.

Internal Combustion Engines Using Digester Gas: Instead of being flared, digester gas produced from anaerobic digestion can be used as the fuel for internal combustion engines. These engines are used for both electricity and heat (cogeneration) at wastewater treatment facilities.

Micro-hydro Turbines: Wastewater treatment facilities have an available renewable resource in the flow of water through the plant. Any energy from flow not required for plant operation and the energy from flow obtained from small turbines at the outfall of the plant can be used to produce renewable power.

Microturbines Using Digester Gas: Instead of being flared, digester gas produced from anaerobic digestion can be used to power microturbines. Microturbines are similar to larger traditional combustion turbines, or small jet engines, but spin at much faster speeds. Pressurized fuel (digester gas) is supplied to the combustor, mixed with fuel, and burned. The heated combusted gases expand, powering the turbine that operates the generator and therefore producing electricity.

Solar Photovoltaic Systems: Solar energy refers to a wide array of renewable energy technologies that derive their energy from the sun. Photovoltaic (PV) systems convert sunlight directly into electricity. Electrons in certain types of crystals (contained in PV systems) are freed by solar energy and are induced to travel through an electrical circuit. This process produces electrical energy. Most PV systems include batteries that allow them to continue providing power during the nighttime when there is no sun to provide energy.

The municipal wastewater treatment plant in Charlemont, Massachusetts installed a 15 kilowatt (kW) photovoltaic solar array that has reduced its energy costs by 54% since the project was completed in May of 2005. The project, which includes 96 solar panels mounted on 8 poles connected to 3 inverters, was designed to provide 50% of the plant's electric needs and has been performing above its design capacity. In the three years since the panels went online, the average June energy use has dropped to only 950 kWh, a 62% reduction. The plant used a grant program offered by the Massachusetts Renewable Energy Trust to offset 50% of the $142,000 cost of the project. The original payback time of 17 years has shrunk as energy prices have risen since the panels were installed. In addition to the financial savings the solar panels generate for the plant, the environmentally-friendly panels reduced the facility's CO_2 footprint by nearly 17 tons in the first 2 years of operation.

On-site Small Wind Turbines: Small wind electric systems are defined as wind turbines with no more than 100 kilowatts capacity. They are usually used for home, telecommunications dishes, or water pumping. The wind turbine collects energy from the wind and converts it to electricity that is compatible with a building's electrical system. At 100 feet or more aboveground, they can take advantage of faster and less turbulent wind. Usually small wind turbines consist of two or three blades that are 25 feet in diameter. The small wind turbine will not produce power at wind speeds below 7-10 miles per hour. Grid-connected small wind turbines do not include batteries. Off-grid small wind turbines do have batteries that are charged when the wind is blowing – providing for power when there is no wind.

Fats-Oils-Grease and Green Waste: Fats, oils and grease (FOG) are a significant and problematic component of domestic wastewater. While some FOG is produced from residences, the main sources are commercial and industrial waste streams. In a typical community, restaurants are generally the largest source of FOG. Green waste is food scrap waste that is biodegradable. FOG is also a significant source of sanitary sewer overflows. The greasy waste can cause blockages and eventual breakages in sewer lines – causing leaks and overflows.

FOG and green waste can create additional quantities of digester gas that can be used as a fuel to create electricity. Facility grease trap waste and food scrap waste is considered ideal for anaerobic digestion at wastewater treatment facilities – as an alternative to landfill disposal. The challenge to FOG and green waste is related to successfully receiving, conditioning, and feeding the waste into the anaerobic digester.

Advanced Motors, Engines, and Pumps: Some wastewater treatment facilities still use equipment that was designed decades ago. In the intervening years, newer, more advanced products have become available that are more energy efficient.

For example, the Bath Water District in Bath, Maine, is saving more than $30,000 a year as a result of new variable frequency drives on two pumps. The drives adjust the speed of the pumps according to the volume of water they need to pump to meet demand. Before the upgrade, the pumps operated only at their maximum speed when in use. The $60,000 project was subsidized by a $15,000 incentive from Efficiency Maine, giving it a payback of only 18 months. The facility has saved about 376,000 kWh annually since the upgrades in 2003, the same amount of energy used by 35 homes in a year. The project also have a tangible climate-related impact: the energy savings translate into a reduction of more than 208 tons of carbon dioxide a year.

Aerators are another type of wastewater treatment technology that can be replaced with more efficient systems. Aerators mix oxygen into wastewater ponds to facilitate the breaking down of waste by the natural organisms contained in the ponds, and used in the wastewater treatment process. The City of Astoria, Oregon replaced its 25-year old aerator with a more efficient system in 2003. The older, mechanical system ran constantly and consumed approximately 920,000 kWh per year. The new system is a compressed air wastewater system that operates only when needed, and which uses 375,000 kWh per year. This has resulted in estimated savings of nearly $23,000 a year. The new system cost Astoria $341,000. Given the energy savings of the new aerator, Astoria expects to pay off the loan used for the purchase in approximately 10 years.

Energy Audits: EPA, through its Energy Star program, encourages facilities to engage in energy audit processes to make improvements in energy efficiency. Based on the general Energy Star process for structures, an energy audit process should consist of: a) establishing overall energy objectives; b) performing the energy audit; c) setting baselines; d) establishing an energy plan and setting performance goals; e) tracking performance over time; and f) periodically evaluating energy use.

The initial energy audit, itself, should be conducted with broad-based energy use objectives in mind. For example, does a facility want to increase energy efficiency? Or, does a facility want to achieve energy independence? The audit can assess energy consumption at each of the primary operational areas that significantly affect energy use. These include: plant engineering; purchasing; operations and maintenance; building and facility management; environmental health and safety; corporate real estate and leasing; construction management; contractors and suppliers; and utilities. Data and information from the initial energy audit can be used to establish a baseline against which progress can be measured. The facility's energy plan will include performance goals, facility policies, and technical upgrades aimed at achieving facility energy objectives. Over time, subsequent energy audits should be periodically conducted to track performance and allow for evaluation of the energy plan. This process will help facility managers to determine whether energy efficiency goals have been achieved, will identify facility best practices, and will inform decisions about how to achieve future energy efficiency or independence goals.

Sustainable Infrastructure – Planning, Design, and Construction

Sustainable planning, design, and construction encompass a wide range of activities that can result in lower impacts on watersheds, as well as increases in energy efficiency. For example, decentralized wastewater treatment systems obviate the need for a large, centralized wastewater treatment facility. Similarly, the size of the collection system infrastructure can be made significantly smaller. Decentralized wastewater treatment systems consist of small-scale sewage treatment systems that treat wastewater on the neighborhood scale.

Sustainable building approaches can result in the increased re-use of materials, decreased runoff, and increased energy efficiency. These approaches can be applied to the construction and retrofitting of elements of a wastewater treatment facility. According to the Green Building Council, buildings in the United States account for 72% of electricity consumption, 39% of energy use, 38% of all carbon dioxide (CO_2) emissions, 40% of raw material use, 30% of waste output, and 14% of potable water consumption. Green building approaches seek to decrease many of these factors through the use of energy efficient materials, non-toxic construction materials, natural lighting, and the capture of stormwater, among others. These design, planning, and construction approaches can result in numerous economic, environmental, and health and community benefits. Economic benefits include reduced operating costs, enhanced asset value and profits, and improved employee productivity and satisfaction. Environmental benefits include improved air and water quality, reduced solid waste, conservation of natural resources, and enhanced habitat protection and sustained biodiversity. Health and community benefits include improved air, thermal, and acoustic environments, minimized strain on local infrastructure, and enhanced occupant health and comfort.

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